

May 13, 1869.

Dr. WILLIAM ALLEN MILLER, Treasurer and Vice-President,
in the Chair.

In conformity with the Statutes, the names of the Candidates recommended for election into the Society were read from the Chair, as follows :—

Sir Samuel White Baker, M.A.
John J. Bigsby, M.D.
Charles Chambers, Esq.
William Esson, Esq., M.A.
George Carey Foster, B.A.
William W. Gull, M.D.
J. Norman Lockyer, Esq.
John Robinson McClean, Esq.
St. George Mivart, Esq.

John Russell Reynolds, M.D.
Vice-Admiral Sir Robert Spencer
Robinson, K.C.B.
Major James Francis Tennant, R.E.
Wyville Thomson, LL.D.
Col. Henry Edward Landor Thuillier,
R.A.
Edward Walker, Esq., M.A.

The following communications were read :—

- I. "On some of the minor Fluctuations in the Temperature of the Human Body when at rest, and their Cause." By A. H. GARROD, St. John's College, Cambridge. Communicated by Dr. BEALE. Received April 16, 1869.

The author's object in the following communication is to show that the minor fluctuations in the temperature of the human body, not including those arising from movements of muscles, mainly result from alterations in the amount of blood exposed at its surface to the influence of external absorbing and conducting media.

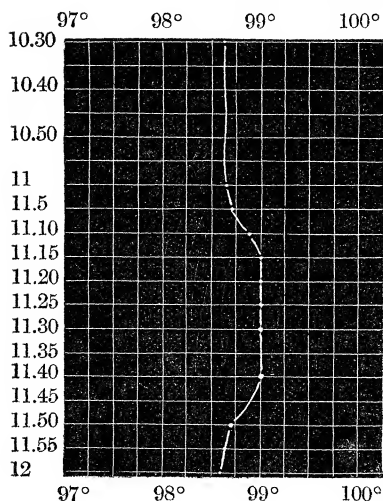
In the following Tables, when not otherwise mentioned, all the temperatures are taken under the tongue, the thermometer remaining in the mouth for five minutes, except when the observations were made each two-and-a-half minutes, on which occasions the temperature of the bulb was not allowed to fall below 85° F.

It may be remarked that in no case mentioned below was the temperature of the air above 65° F., and that on all occasions the skin was dry, whereby any complications from the presence of perceptible moisture were avoided; and the arguments based on the facts necessitate an approximation to those conditions.

The Tables have been selected from a great number of observations; and no results have been obtained which are not easily explained on the theory given.

The temperatures were taken on one subject, aged 22, male, thin.

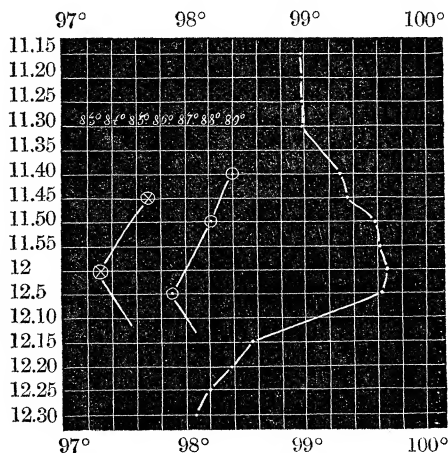
No. I.—From 10.30 P.M. till 12 night.



Sitting in a room (temp. of air 66° F.) all the time. Fully clad till 11, when stripped in a minute, therefore nude at 11.1. Warm when dressed, but got cold when nude. At 11.40 covered body all over with a thick blanket, soon followed by a slight skin-glow. In the blanket until 12 night.

When body covered, pulse much more bounding than when not covered.

No. II.—From 11.15 P.M. till 12.30 night.

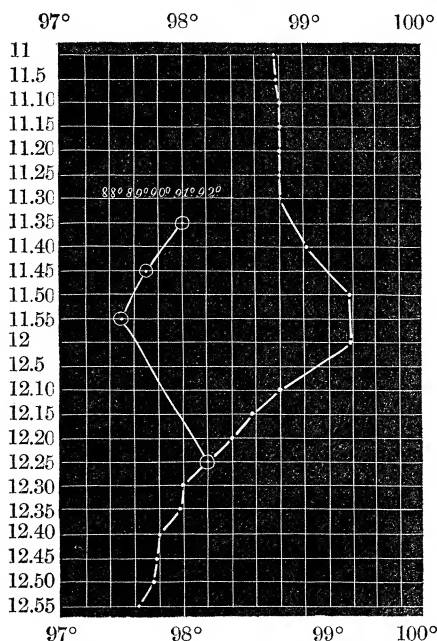


Standing from 11 till 12.5 in a room with the thermometer at 47° F., warmly clad till 11.30, when stripped in two minutes, so nude at 11.32. Fairly warm all the while. Got to bed at 12.6, and lay closely wrapped by bedclothes for the rest of the time. A decided glow came on at 12.11½, lasting a minute, after which feet became a little cold, but skin of body quite warm.

Whilst standing nude pulse small, but bounding when dressed and when in bed.

⊙ Indicates the temperature of the pectoral region, two inches above the nipple, taken by placing, for five minutes, a flat spiral thermometer on the part.

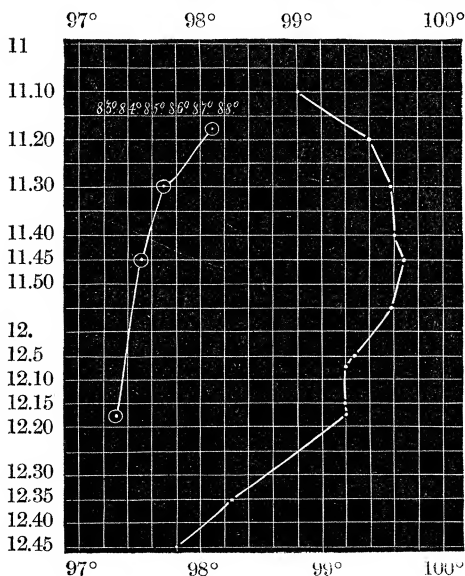
⊕ Indicates the temperature of the front of the thigh, with the same instrument as the last.

No. III.—*From 11 P.M. till 1 A.M.*

Standing in room (temp. of air 52° F.) from 11 until 12. Fully clad until 11.30, and then stripped in two minutes, so nude at 11.32. Warm in body all the while. At 12.2 got to bed, and there the rest of the time, closely wrapped. A glow came on at 12.8½, lasting half a minute, after which feet became coldish.

Pulse not so bounding when nude as when body covered.

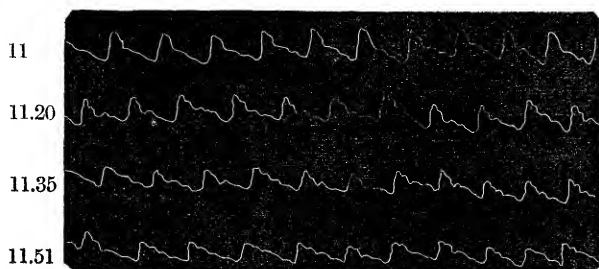
○ Indicates the temperature of the pectoral region, found by placing a spiral flat thermometer on it, and keeping it there five minutes.

No. IV.—*From 11 P.M. till 12.45 night.*

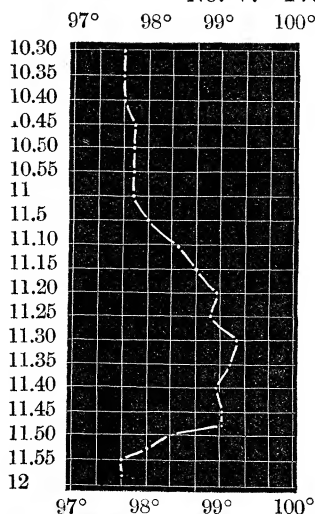
Nude at 11.11 in a room (temp. of air 56°). Standing from 10.50 until 12.20 nude. At 12.21 got to bed, and remained there rest of time. At 11.45 began moving about and stooping, and whenever stooped felt a chill. Quite shivering from 11.57½ till 12.7½, when, leaving off moving, the shivering ceased.

When in bed had no marked glow, and feet continued to be warm; skin of thighs not warm.

The following is the sphygmographic curve of radial artery at wrist: when in bed at 12.40, pulse same as at 11 (the same pressure was used on the sphygmograph-spring in all the traces):—



No. V.—From 10.30 P.M. till 12 night.

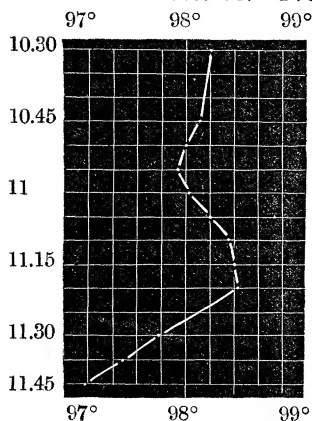


Sitting in a room (temp. of air 58° F.) all the time. Warmly clad till 11, when stripped in two minutes, so nude at 11.2. At 11.20 went for half a minute into a colder room. At 11.45 put on several flannel things, which had been warmed by the fire, and sat in front of a warm fire.

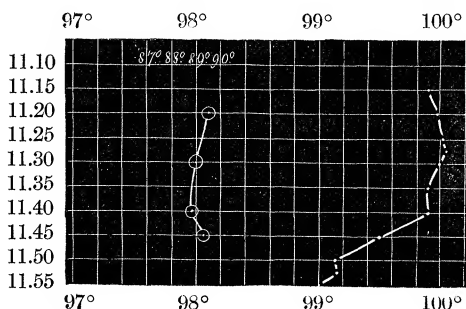
Took sphygmograph-trace from right superficialis volæ at 10.40 and at 11.10. Tried to do so at 11.40, but could not get any indication, from the smallness of its pulsation. At 12 the pulsation was as great as at 10.40.



No. VI.—From 10.30 P.M. till 11.45 P.M.

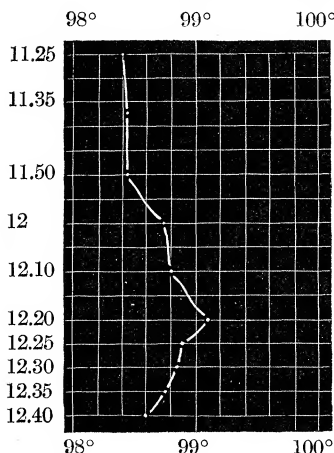


Sitting in a room (temp. of air 59° F.) from 9.30 until 10.40, quiet, cool, and warmly clad. From 10.40 till 10.55 moving about in the same room. Stripped at 10.55, and nude in two minutes. Remained nude until 11.24, when got to bed, and remained there for the rest of the time.

No. VII.—*From 11.10 P.M. till 11.55 P.M.*

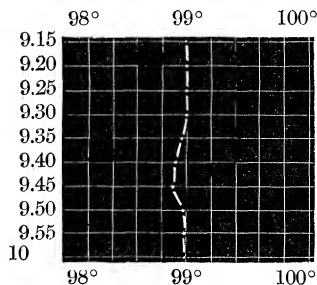
Standing in a room (temp. of air 53° F.) from 11 until 11.25. Fully clad until 11.9, when stripped, and nude at 11.10. Continued nude until 12. At 11.25 seated, and remained so until 12, on a bed. At 11.40 put feet in water from 110°–114°, above ankles, and remained thus rest of time, maintaining the heat of the water. Chilly when feet in bath, not before. At 11.52½ contracted limb muscles tonically, and maintained them so until 11.55.

○ Indicates temperature of pectoral region, two inches above nipple, taken with spiral thermometer, for five minutes.

No. VIII.—*From 11.25 P.M. till 12.40 night.*

Standing in a room (temp. of air 58° F.) from 11 until 12, and sitting during the rest of the time on a bed. Fully clad until 11.50. Nude from 11.52, and remained so. Feet a little cold at 12.20, and put them into hot water (108°–114°) at 12.21, gradually increasing the heat of the water. Kept feet in water, above ankles, until 12.40.

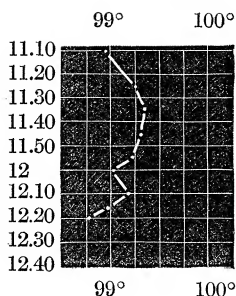
On adding more hot water and putting feet in it chills followed.

No. IX.—*From 9.15 A.M. till 10 A.M.*

Sitting all the while in a room (temp. of air 52°), not far from an ordinary fire.

Felt cold all over during the time. Reading. At 9.30 turned to the fire and put feet on the fender, having been previously quite at the side of the fireplace. As feet got warm, hands, which were previously warm, became cold.

Clad in winter clothes.

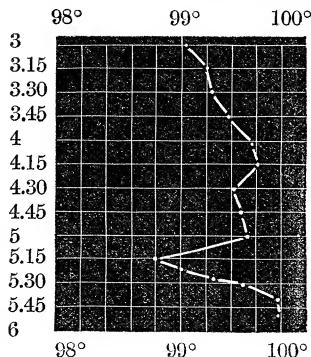
No. X.—*From 11.10 A.M. till 12.40 P.M.*

Temperature of air 62° F. A cloudy, breezy day. At 11 walked about 200 yards on to a beach, and sat down on the shingle at 11.5, where there was a slight side breeze. Hands and feet a little cold.

Sun covered by clouds until 11.35, after which it began to shine; immediately after which began to feel warm, and continued to get warmer until 12.7, when at 12.7 a cloud covered sun until 12.11. During time sun covered, several chills came over body.

Walking in sun from 12.16 onward.

Clad in thin merino next skin and summer clothes.

No. XI.—*From 3 P.M. till 6 P.M.*

Temperature of air 66° F., slowly diminishing to 64° F. Sitting on a beach from 3 until 5, after a dinner at 2.15–2.45. A slight face breeze. In the shade. Warm until 4.15, when feet began to get a little cold, and by 5 so cold that obliged to move about. At 5 began to walk slowly, and had to go up several steps. At 5.20 began to walk briskly. Began to perspire at 5.25. Continued walking, perspiring until 6.

Clad as in last.

To explain these Tables :—

The actual temperature of the body at any given moment must be the resultant of (1) the amount of heat generated in the body, and (2) the amount lost by conduction and radiation.

(1) The *source* of heat in the body is not considered in this paper; and no more will be now said of it, except that there is every reason to believe that it is not in the skin itself, and that, for the short periods through which each observation was made, it is approximately uniform.

(2) The *loss* of heat from the body is modified by changes in the skin and by changes in the surrounding media; and these two are mutually dependent.

It has long been known that cold contracts and heat dilates the small arteries of the skin, respectively raising and lowering the arterial tension, and thus modifying the amount of blood in the cutaneous capillaries.

But modifications in the supply of blood to the skin must alter the amount of heat diffused by the body to surrounding substances; and so we should expect that by increasing the arterial tension, thus lessening the cutaneous circulation, the blood would become hotter from there being less facility for the diffusion of its heat, and that by lowering the ten-

sion, thus increasing the cutaneous circulation, the blood would become colder throughout the body, from increased facility for conduction and radiation.

That such is the case is proved by Tables I., II., III., IV., V., and VI., where, by stripping the warm body of clothing, in a cold air, when the tension was low (as in Tables IV., V., shown by the sphygmograph-trace), the temperature and tension rose, at the same time that the surface became colder.

In Tables I., II., III., IV., V., and VI., by covering the nude body with badly conducting clothing, when the tension was high, the surface-heat soon accumulated sufficiently to cause a sudden reduction of arterial tension, commonly called a glow, and a rapid fall in the temperatures, from the larger amount of blood exposed at the surface of the body to the influence of colder media.

Changes in the arterial tension are easily recognized by the subject of experiment, from the sensations they produce; a feeling of warmth followed by a shiver, or a shiver itself, generally shows that the tension is lowered, while the opposite effect follows a rise in the tension; and this can be generally confirmed by the sphygmograph-trace. A bounding weak pulse shows a low, and a small thready one a high tension.

We know, from the observations of Davy and others, that by reducing the tension in one part of the body the tension of other parts is lowered; thus by placing one hand in hot water, a thermometer in the other rises. In Tables VII. and VIII. it is shown that by putting the feet in hot water (at 110° to 115°) the lowering of the tension was so great that the amount of heat lost into the air considerably exceeded that gained to the body from the water, so that the temperature of the body began to fall directly, and decreased considerably; and it was noticed that on adding more hot water chills were produced, which was the same as the effect of first putting the feet in the water.

By covering a small part of the body with a bad conductor, the tension of the whole body soon falls, from the accumulation of heat in the covered parts causing a lowering in the tension generally, and a consequent greater carrying away of heat. In this way the fall after sitting down on a bad conductor when nude can be explained (Table VII.).

A glow is felt in the skin directly upon short muscular movement, as stooping, and the temperature falls at the same time, as in Table IV., between 11.45 and 12.20, and in Table XI., between 5.0 and 5.15. In the latter case the muscular movement was carried to such an extent that the loss was made up for by the increase of heat from the muscular movement.

Simply heating the feet lowers the tension and temperature together, as in Table IX. and in Table X. The passage of a cloud before the sun seems to have acted by reducing the loss of heat, as the temperature rose at the time.

Further confirmation of the facts stated as to the modification of arterial tension may be found in Marey's work, '*De la Circulation du Sang*,' published in Paris in 1863. In that book the author ascribes the uniformity of the heat in the internal parts to the same cause as the author of the present paper ascribes the variations.

The fact observed by Dr. W. Ogle in the St. George's Hospital Reports for 1866, and by Drs. Ringer and Stewart in a paper read before the Royal Society this year, that the temperature falls at night, and is lowest at from 12 to 1 A.M., and begins to rise after that time, is simply explained on the theory given above; for it depends on the custom of Englishmen going to bed at about that hour, and thus giving a large amount of heat to the cold bedclothes, which at first is expended in warming the sheets &c., while later on in the night the bedclothes are warm, and therefore the body has only to make up for the heat diffused.

Other natural phenomena can be similarly explained. Thus, on a cold day, the effect of sitting with one side of the body in the direct rays of a fire is to cause the other side to feel much colder than if there was no fire at all, because the fire lowers the tension over the whole body, and supplies heat to the full cutaneous vessels of one side, while the other side, being equally supplied with blood in the skin, does not receive heat, but has to distribute it rapidly to the cold clothes &c.

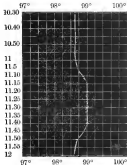
II. "Observations of the Absolute Direction and Intensity of Terrestrial Magnetism at Bombay." By CHARLES CHAMBERS, Esq., Superintendent of the Colaba Observatory. Communicated by Lieut-General SABINE, R.A., President. Received April 5, 1869.

(Abstract.)

The observations made by the author were of the three usual elements—the Dip, Declination, and Intensity of the Horizontal Component of the Force. They were taken with instruments supplied to the Colaba Observatory in the year 1867 through the Kew Committee of the British Association, after having been tested at the Kew Observatory. The dip-circle was made by Barrow of London, and is furnished with two needles; the other instrument, the unifilar magnetometer, which serves both for observations of declination and horizontal force, was made by Elliott Brothers of London. The results of the observations for dip only have as yet been received from the author.

A complete observation consists of thirty-two readings, each end of the needle being read twice in each different position of the needle and circle; and the mean of the thirty-two is taken as the result of the observation. The observations were 178 in number, commencing on the 29th of April 1867, and extending to the 29th of December 1868. They were generally taken, with the two needles alternately, on particular days of the

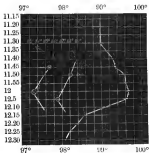
No. I.—*From 10.30 p.m. till 12 night.*



Sitting in a room (temp. of air 66° F.) all the time. Fully clad till 11, when stripped in a minute, therefore nude at 11.1. Warm when dressed, but got cold when nude. At 11.40 covered body all over with a thick blanket, soon followed by a slight skin-glow. In the blanket until 12 night.

When body covered, pulse much more bounding than when not covered.

No. II.—*From 11.15 P.M. till 12.30 night.*



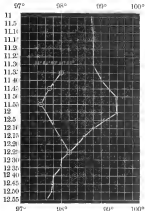
Standing from 11 till 12.5 in a room with the thermometer at 47° F., warmly clad till 11.30, when stripped in two minutes, so nude at 11.32. Fairly warm all the while. Got to bed at 12.0, and lay closely wrapped by bedclothes for the rest of the time. A decided glow came on at 12.11½, lasting a minute, after which feet became a little cold, but skin of body quite warm.

Whilst standing nude pulse small, but bounding when dressed and when in bed.

○ Indicates the temperature of the pectoral region, two inches above the nipple, taken by placing, for five minutes, a flat spiral thermometer on the part.

× Indicates the temperature of the front of the thigh, with the same instrument as the last.

No. III.—From 11 P.M. till 1 A.M.

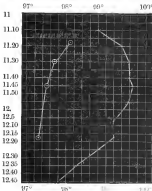


Standing in room (temp. of air 52° F.) from 11 until 12. Fully clad until 11.30, and then stripped in two minutes, so nude at 11.32. Warm in body all the while. At 12.2 got to bed, and there the rest of the time, closely wrapped. A glow came on at 12.34, lasting half a minute, after which feet became coldish.

Pulse not so bounding when nude as when body covered.

⊙ Indicates the temperature of the pectoral region, found by placing a spiral flat thermometer on it, and keeping it there five minutes.

No. IV.—*From 11 p.m. till 12.45 night.*



Nude at 11.11 in a room (temp. of air 59°). Standing from 10.50 until 12.20 nude. At 12.21 got to bed, and remained there rest of time. At 11.45 began moving about and stooping, and whenever stooped felt a chill. Quite shivering from 11.57½ till 12.7½, when, leaving off moving, the shivering ceased.

When in bed had no marked glow, and feet continued to be warm; skin of thighs not warm.

The following is the sphygmographic curve of radial artery at wrist: when in bed at 12.40, pulse same as at 11 (the same pressure was used on the sphygmograph-spring in all the traces):—

11

11.30

11.35

11.51



No. V.—From 10.30 p.m. till 12 night.

97° 98° 99° 100°

10.30

10.35

10.40

10.45

10.50

10.55

11

11.5

11.10

11.15

11.30

11.35

11.36

11.36

11.40

11.45

11.50

11.55

12



97° 98° 99° 100°

Sitting in a room (temp. of air 58° F.) all the time. Warmly clad till 11, when stripped in two minutes, so nude at 11.2. At 11.30 went for half a minute into a colder room. At 11.43 put on several flannel things, which had been warmed by the fire, and sat in front of a warm fire.

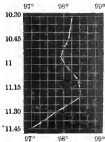
Took sphygmograph-trace from right superficialis vein at 10.40 and at 11.10. Tried to do so at 11.40, but could not get any indication, from the smallness of its pulsation. At 12 the pulsation was as great as at 10.40.



10.40.

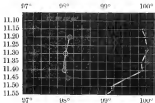
11.10.

No. VI.—From 10.30 P.M. till 11.45 P.M.



Sitting in a room (temp. of air 59° F.) from 9.30 until 10.40, quiet, cool, and warmly clad. From 10.40 till 10.55 moving about in the same room. Stripped at 10.55, and nude in two minutes. Remained nude until 11.34, when got to bed, and remained there for the rest of the time.

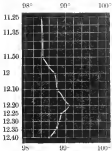
No. VII.—*From 11.10 P.M. till 11.55 P.M.*



Standing in a room (temp. of air 53° F.) from 11 until 11.25. Fully clad until 11.9, when stripped, and nude at 11.10. Continued nude until 12. At 11.25 seated, and remained so until 12, on a bed. At 11.40 put feet in water from 110° – 114° , above scales, and remained thus rest of time, maintaining the heat of the water. Chilly when feet in bath, not before. At 11.52½ contracted limb muscles tonically, and maintained them so until 11.55.

⊙ Indicates temperature of pectoral region, two inches above nipple, taken with spiral thermometer, for five minutes.

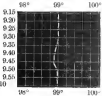
No. VIII.—From 11.25 P.M. till 12.40 a.m.



Standing in a room (temp. of air 58° F.) from 11 until 12, and sitting during the rest of the time on a bed. Fully clad until 11.50. Nude from 11.52, and remained so. Feet a little cold at 12.20, and put them into hot water (108°-114°) at 12.21, gradually increasing the heat of the water. Kept feet in water, above ankles, until 12.40.

On adding more hot water and putting feet in it chills followed.

No. IX.—From 9.15 A.M. till 10 A.M.



Sitting all the while in a room (temp. of air 62°), not far from an ordinary fire.

Felt cold all over during the time. Reading. At 9.30 turned to the fire and put feet on the fender, having been previously quite at the side of the fireplace. As feet got warm, hands, which were previously warm, became cold.

Clad in winter clothes.

No. X.—From 11.10 A.M. till 12.40 P.M.



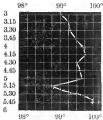
Temperature of air 62° F. A cloudy, breezy day. At 11 walked about 200 yards on to a beach, and sat down on the shingle at 11.5, where there was a slight side breeze. Hands and feet a little cold.

Sun covered by clouds until 11.35, after which it began to shine; immediately after which began to feel warm, and continued to get warmer until 12.7, when at 12.7 a cloud covered sun until 12.11. During time sun covered, several chills came over body.

Walking in sun from 12.16 onward.

Cloth in thin merino next skin and summer clothes.

No. XL.—From 3 P.M. till 6 P.M.



Temperature of air 88° F., slowly diminishing to 84° F. Sitting on a bench from 3 until 5, after a dinner at 3.15-3.45. A slight face breeze. In the shade. Warm until 4.15, when feet began to get a little cold, and by 5 so cold that obliged to move about. At 5 began to walk slowly, and had to go up several steps. At 5.30 began to walk briskly. Began to perspire at 5.35. Continued walking, perspiring until 6.

Clad as in last.